Regional perspectives and opportunities for feral hog management in Texas

Clark E. Adams, Billy J. Higginbotham, Dale Rollins, Richard B. Taylor, Raymond Skiles, Mark Mapston, and Saidor Turman

Abstract In 2003 we conducted a study to determine the consequences of feral hog (*Sus scrofa*) invasions in several ecoregions of Texas. We examined the observations, experiences, and actions of landowners and managers concerning feral hogs on their property. We used purposive sampling of landowners and managers who fit 1 or more of 3 selection criteria. Landowners and managers were either sent a self-administered, mail-out questionnaire or given a copy of the questionnaire during pesticide applicator workshops. There were 775 survey participants. The effective response rate from those landowners and managers who received a mailed questionnaire was 62% (n=284). Nearly all (95%, n=491) of the pesticide applicator workshop participants turned in a completed questionnaire. Sampling error based on the farms (includes ranches) in Texas and in each region was ±3%, α=0.05. The majority (74%) of respondents were ranchers, and 18% were farmers. Most respondents felt that feral hogs came from the neighbor's property and were an agricultural pest. Rooting, wallowing, and crop damage were the major forms of damage caused by feral hogs. The average economic loss due to hog damage, over the lifetime ownership of the land by the respondent, was $7,515 (U.S). Hog control was an incidental process. The average cost for hog control over the lifetime ownership of the land by the respondent was $2,631 (U.S.). There was strong support for programs related to feral hog management and control, but only half of the survey participants responded to the question. The average quiz score of 11.5 indicated that respondents could correctly respond to <50% of the 26 questions. Region was found to have an effect ($P \leq 0.05$) on all questions tested except one. Management implications included the need for educational programs about feral hogs, how landowners can make better use of feral hogs on their property, ongoing education efforts about feral hogs, and the impact of this study on the public policy and decision-making process.

Key words feral hogs, landowner, survey, *Sus scrofa*, Texas

Address for Clark E. Adams: Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843-2258, USA; e-mail: clark.adams@tamu.edu. Address for Billy J. Higginbotham: Texas A&M University, Agricultural Research and Extension Center, P.O Box 38, Overton, TX 75684, USA. Address for Dale Rollins: Texas A&M University, Agricultural Research and Extension Center, 7887 U.S. Highway 87 N., San Angelo, TX 76901, USA. Address for Richard B. Taylor: Texas Parks and Wildlife, P.O. Box 5207, Uvalde, TX 78802, USA. Address for Raymond Skiles: P.O. Box 129, Big Bend National Park, TX 79834, USA. Address for Mark Mapston: Texas Cooperative Extension-Wildlife Services, 122 North East St., Uvalde, TX 78801, USA. Address for Saidor Turman: United States Department of Agriculture-Animal and Plant Health Inspection Service-Wildlife Services, POB 1521, Ft. Stockton, TX 79735, USA.

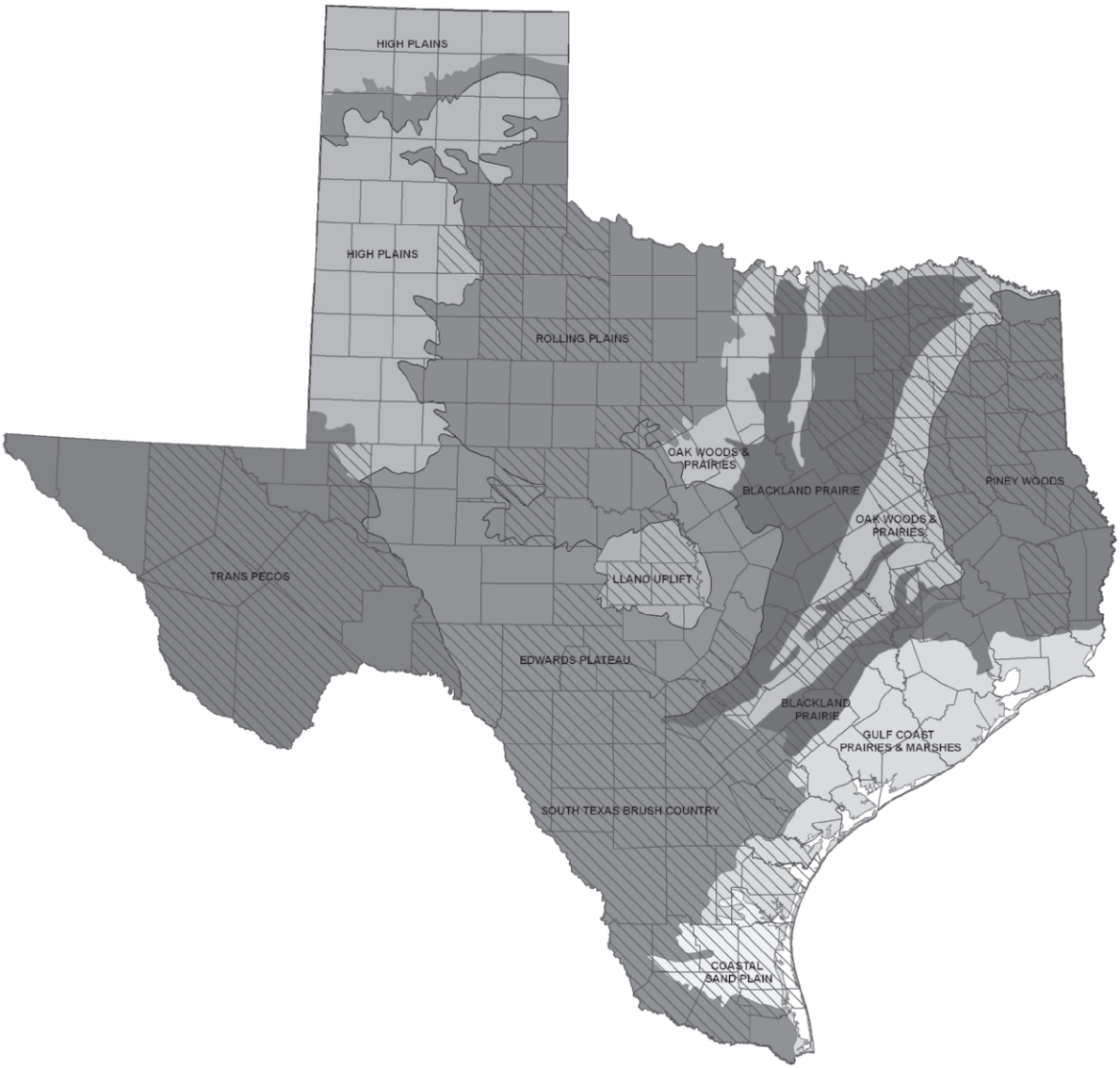

Figure 1. Ecoregions and counties (hatched areas) in Texas where a landowner or manager survey about feral hogs was conducted in 2003.

Feral hogs (*Sus scrofa*) are distributed throughout much of Texas, with the highest population densities occurring in the Piney Woods, Coastal Prairie, Edwards Plateau (includes Llano Uplift), South Texas Brush Country (includes Coastal Sand Plains), and Rolling Plains ecoregions (Figure 1). The Trans-Pecos ecoregion had few feral hogs, but they are beginning to expand their range into this ecoregion (Taylor 1993). By 1990 feral hogs were established in the Davis Mountains, north of Big Bend National Park located in the southern tip of the Trans Pecos ecoregion (Figure 1). By 1998 southward range expansion resulted in feral hogs encroaching on Big Bend National Park located in the western Trans Pecos ecoregion of Texas (R. Skiles, Big Bend National Park, personal communication).

Success of feral hog control anywhere they occur is highly dependent upon the activities of local landowners. Given the potential damage that feral hogs can inflict on the biotic resources of park and private lands, one plan of action was to determine how landowners address feral hog management. An objective assessment of landowners concerning feral hog management was needed (Gipson et al. 1998). In addition, educational programs are need-

ed to provide factual information about feral hogs to landowners and special interest groups. Previous published studies of landowner surveys concerning feral hogs on their property focused on potential economic returns from feral hogs (Degner et al. 1982); and landowners' attitudes toward feral hogs, management activities, and property-damage estimates (Barrett and Pine 1980). As interest in feral hogs and their management increased, a national feral hog symposium was conducted in Kerrville, Texas in 1993 (Hanselka and Cadenhead 1993).

In 2003 we conducted a study to determine the consequences of feral hog invasions in several ecoregions of Texas (Figure 1). The study focused on the observations, experiences, and actions of landowners and managers concerning feral hogs on their property. The objectives of this study were to develop a baseline analysis of landowners' and managers' views on 1) the historical occurrence of feral hogs on their land, 2) origin of feral hogs on their land and present population estimates, 3) the positive and negative values of feral hogs, 4) the types of damage caused by feral hogs and economic losses, 5) control strategies and costs of control, and 6) becoming involved in feral hog management and educational opportunities. To develop educational programs about feral hogs, it was important to determine landowners' knowledge of selected aspects of feral hog biology, natural history, and regulatory status.

Study area

The study area consisted of several ecological ecoregions in Texas (Figure 1). We chose ecoregions based on the historical occurrence (e.g., recent or long-term) of feral hogs within the counties of each region. This study did not include the High Plains ecoregion in Texas (Figure 1). The High Plains and extreme west Texas are outside the present range of feral hogs in the state. Feral hogs cause significant damage to rice fields, levees, fences, and country roads in the Gulf Coast Prairie and Marshes ecoregion (N. Wilkins, Texas Cooperative Extension, personal communication). However, we did not have access to a purposive sample (explained below) of landowners and managers from this region, which prevented its inclusion in this study.

Methods

Purposive sampling was used by Schuett and Selin (2002) to select landowner respondents based on their involvement in 5 different forest management initiatives. In our study, we selected participants that represented a particular ecological region (Figure 1), facilitated the management of the natural resources on their properties, and were accessible through an existing database or activity. Our selection of survey participants was not designed to represent a cross-section of all rural landowners in Texas. Rather, we wanted to obtain a representative sample of the total number of farms and ranches at the region level.

One part of the surveyed population consisted of landowners and managers representing the South Texas Brush Country, Edwards Plateau, Rolling Plains, and Trans Pecos ecoregions of Texas (Figure 1). These landowners and managers were sent a self-administered, mail-out questionnaire by the agency representatives (e.g., Texas Parks and Wildlife, Texas Cooperative Extension, and Wildlife Services) who had the names and addresses of the types of landowners who fit our selection criteria. Two weeks later a reminder card was sent to each landowner or manager by the agency representative.

Landowners and managers who participated in pesticide-applicator workshops (mandatory for recertification) fit our selection criteria and represented the Piney Woods, Blackland Prairie, and Oak Woods Prairies ecoregions of Texas (Figure 1). These landowners and mangers were given a copy of the questionnaire at the beginning of the workshop. Completed questionnaires were collected at the end of the workshop.

Completed questionnaires were sent back to the Human Dimensions in Wildlife Management Research Laboratory and Texas A&M University in a return mailer. Our anonymous survey administration prevented a second mailing of the questionnaire, nonresponse follow-ups, and a determination of nonresponse bias. A more important concern was item nonresponse discussed later in the paper.

The questionnaire

The questionnaire began by determining whether feral hogs existed on the properties owned or managed by respondents. If there were feral hogs, a follow-up question asked for the county name(s) and the year hogs were first observed. The questionnaire asked how hogs got on the land, and whether the numbers had changed since they were first observed. We asked questions regarding values (positive and negative) of having hogs on the

Table 1. Results of a feral hog quiz taken by 775 Texas landowners and managers in 2003.

Statements: "Feral hogs -"	Agree	Disagree	Not sure
a. compete with other wildlife species for food.	622*	34	60
b. are a serious threat to ground-nesting birds.	514	29*	163
c. prey on snakes – even rattlesnakes.	327*	35	321
d. prey on healthy newborn livestock, e.g., lambs.	314*	84	298
e. destroy game feeders.	570*	37	95
f. that root in the soil benefit some game birds.	203*	179	295
g. are an exaggerated risk to other wildlife.	224*	213	231
h. eat anything they can catch alive or find dead.	456	66*	179
i. carry diseases harmful to humans.	286*	73	328
j. eat mostly plant material.	351*	189	143
k. compete with other wildlife at unknown levels.	531*	23	136
l. do not appear to pose a significant threat to wildlife.	118*	418	146
m. are opportunistic feeders.	571*	26	97
n. breed year-round.	611*	22	76
o. have, on average, 12 piglets/litter.	331	142*	220
p. are good to eat.	421*	123	135
q. have their numbers controlled primarily by human activity.	459*	132	106
r. carry diseases harmful to domestic livestock.	308*	52	328
s. generate a significant source of income for some landowners.	308*	180	192
t. carry diseases harmful to other wildlife.	311*	46	329
u. number in the millions in Texas.	487*	16	194
v. are expanding their range in Texas.	649*	13	51
w. are a game animal regulated by Texas Parks and Wildlife.	50	492*	140
x. are found in most Texas counties	457*	46	197
y. can only be shot by someone with a valid Texas hunting license.	167	386*	138
z. can be moved anywhere in the state without restrictions.	213	202*	277

* = correct answer

property and types and cost of damage done to the property by feral hogs. We asked questions about the intensity, methods, and costs of feral hog control on the property, and the individuals and agencies involved. One question determined respondents' willingness to participate in several feral hog management programs. We then determined how the respondent was associated with the land in terms of how he/she used it and ownership status. A feral hog quiz tested respondents' knowledge of the biology, natural history, and control of feral hogs (Table 1).

Data analysis

Much of the information derived from landowners' responses to questionnaire items is reported as frequencies and summary statistics. We compared regional differences in responses to some questions using chi-square or paired *t*-tests.

Results

Response rates

There were 775 survey participants. The effective response rate from those landowners who received ($n = 455$) a mailed questionnaire was 62% ($n = 284$). The response rates by region ranged from 26% in the Trans Pecos region to 86% in the Edwards Plateau region. Nearly all (95%, $n = 491$) of the pesticide-applicator workshop participants turned in a completed questionnaire.

One hundred and fifty-three of the 775 respondents (20%) reported hogs were not on their property. Unfortunately, they could not be assigned a region because they were not asked to identify their county. This omission produced conservative response rates by farm and ranch and region.

This study included 115 of 254 counties and 954 of the 194,301 farms (includes ranches) in Texas (Wilkins, N., A. Hays, and D. Kubenka. 2003. Texas land trends. Land information systems. http://landinfo.tamu.edu/frag). Sampling error based on the total farms in Texas and in each region was ±3%, $\alpha = 0.05$. Therefore, study results can be generalized at the farm and region level.

Respondents

The majority (74%) of respondents ($n = 775$) were ranchers, and 18% were farmers. Eight percent identified other associations with the land including lease-hunt operators, state land managers, and those who leased the land for grazing cattle or hunting. Absentee landowners represented 21% of

the respondents compared to 72% and 7% who lived on the land>and<than 6 months/year, respectively.

Response patterns to selected questions

Most (56%) respondents reported that feral hogs appeared on their land as a result of immigration from the neighbor's property. Twenty-six percent were not sure where the hogs came from. Only 7 and 8%, respectively, thought the hogs escaped from a domestic herd or were transplanted intentionally. Most (71%) reported that feral hog numbers were increasing on their property compared to 14% who reported hog numbers were stabilizing or decreasing (5%).

Respondents reported feral hogs to be an agricultural pest (89%), a disease hazard (34%), and an environmental (45%) and economic (50%) liability. Only 30% considered feral hogs to be a recreational asset for hunters.

Types of damage reported most often by respondents were rooting damage to roads, ponds, or fields (87%); wallowing in tanks and streams (65%); and crop damage (53%). Fence damage and loss of supplemental feed for livestock or wildlife were reported by 47 and 49% of the respondents, respectively. Less than 10% of respondents reported loss of or disease transmission to livestock, and no damage caused by feral hogs. The average economic loss due to hog damage reported by 344 respondents in 67 counties was $7,515 ± $1,619 (SE) (U.S.). The total reported economic loss since feral hogs appeared on the respondents' property was $2,585,200 (U.S.).

Hog control was an incidental process (i.e., only when the respondent had the time and the situation allowed it) for 61% of the respondents. Intensive hog-control programs (i.e., specific control measures carried out on a regular basis) were conducted by 23% of the respondents. Only 18% did not control hogs. The majority of respondents used trapping (75%) or shooting (87%) methods to control hogs. Only 19% attempted to control hogs with the use of trail-and-catch dogs. Less than 13% used guard animals, hog-proof fences, electric fences, or aerial hunting to control feral hogs. The average economic cost for feral hog control reported by 164 respondents in 51 counties was $2,631± $461 (U.S.). Total reported control costs since feral hogs appeared on the respondents' property was $431,485. Respondents identified themselves (90%) or recreational hunters (48%) as the individuals who conducted feral hog management. Wildlife Services (WS) and private control operators were used by <10% of the respondents.

There was majority (60–66%) support for 1) forming a feral hog control coalition consisting of stakeholders representing private and public lands, state and federal agencies, nongovernmental organizations, and private citizens; 2) establishing a program that monitored the impacts of feral hog expansion; and 3) attending training workshops on feral hog management. However, non-response on this question was high. Only half of the sample population answered ≥1 of the 3 aspects of this question listed above.

Respondents' knowledge of selected aspects of feral hog biology and natural history

We asked respondents to complete a 26-point quiz (a to z) on selected aspects of feral hog biology, natural history, and regulatory control (Table 1). We determined "correct" responses to some questions from information provided in many publications found in Wolf and Conover (2003). The average quiz score for 775 respondents was 11.5±0.17 (range = 0–21). There was no difference on quiz scores between those who did (n=618) and did not (n=154) report hogs on their property.

Ecoregion comparisons

Ecoregion (Figure 1) was considered an appropriate independent variable that would predict how respondents answered selected questions. Ecoregion was selected because of the history of feral hog range expansion in Texas (Taylor 1993) and different ecosystem types and land uses in each region (Wilkins, N., A. Hays, and D. Kubenka. 2003. Texas land trends. Land information systems. http://landinfo.tamu.edu/frag). We found ecoegion to have an effect ($P \leq 0.05$) on all questions that were tested except one. For example, how (χ^2 = 36.4, P = 0.006) and when (χ^2 = 143.3, P = 0.0001) feral hogs appeared on the respondent's land were dependent on region. The majority (range = 51–60%) of the respondents in all ecoregions except the Blackland Prairie reported that hogs immigrated from adjacent properties. However, more respondents in the Blackland Prairie (42%) and South Texas Brush Country (40%) ecoregions did not know where the feral hogs came from compared to only 19–26% of respondents in the other ecoregions. The reported times of first appearance

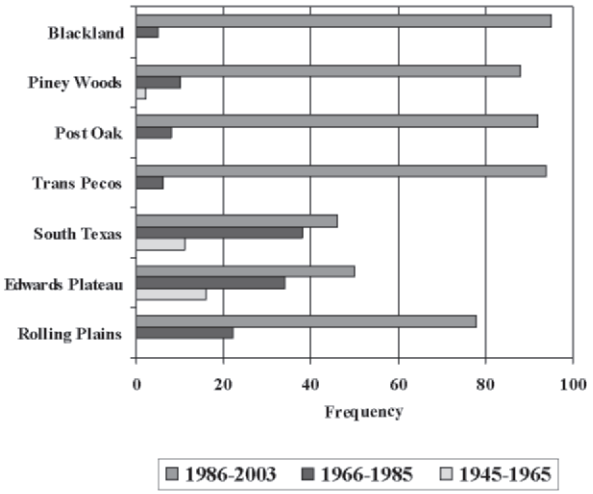

Figure 2. Feral hog arrival times in 7 ecoregions in Texas excluding 1 report of 1900.

of feral hogs ranged from 1900 (one case) to 2003. The earliest arrival times were from 1945–1965 in the Edwards Plateau, South Texas Brush Country, and Piney Woods ecoregions (Figure 2). The most recent (1986–2003) feral hog invasions were in the other ecoregions.

Respondent perceptions of whether the number of feral hogs was increasing, remaining stable, decreasing, or unknown was dependent upon region ($\chi^2 = 35.6$, $P = 0.008$). More South Texas Brush Country and Trans Pecos respondents (11 and 16%, respectively) reported that feral hog populations were decreasing when compared to those in the other ecoregions (range = 0–6%). On the other hand, 13% of the Blackland Prairie and Oak Woods Prairies respondents did not know how the feral hog numbers were changing on their land compared to ≤9% in other ecoregions.

The values that respondents attributed to the existence of feral hogs on their property were dependent on region ($\chi^2 = 156.8$, $P = 0.0001$). Response differences were attributed to higher level of agreement that feral hogs were a recreational asset for hunters in the Edwards Plateau (13%), Rolling Plains (19%), and South Texas Brush Country (23%) ecoregions compared to ≤7% in the other ecoregions. More respondents in the Edwards Plateau, Rolling Plains, and South Texas Brush Country also considered feral hogs as a source of income (7%) compared to ≤4% in the other ecoregions.

Types of damage caused by feral hogs on respondents' property also were dependent on region ($\chi^2 = 167.9$, $P = 0.0001$). Crop damage was reported more often in the farming ecoregions including the Blackland Prairie (18%), Piney Woods and Oak Woods Prairies (16%), and Rolling Plains (21%), and, to a lesser degree, in South Texas Brush Country (12%) compared to ≤7% in the remaining ecoregions. Loss of livestock was reported more in the Edwards Plateau (10%) and Trans Pecos (6%) ecoregions than any of the other ecoregions (≤1%). Finally, more Blackland Prairie respondents (4%) reported no hog damage compared to ≤1% of those in other ecoregions.

How respondents described their feral hog management program ($\chi^2 = 42.8$, $P = 0.0001$) was dependent on region, as was the question on who conducted the management program ($\chi^2 = 100.0$, $P = 0.0001$). Intensive feral hog control was reported most often in the Edwards Plateau and South Texas Brush Country ecoregions. Incidental feral hog control was a prevailing pattern throughout all ecoregions. Nearly a quarter of the respondents in 5 ecoregions reported that they did not control feral hogs (Table 2).

Respondents themselves or recreational hunters were the individuals most involved in feral hog con-

Table 2. Comparisons of the level of feral hog control and who conducted the feral hog program in 7 ecological ecoregions in Texas in 2003.

		Level of feral hog control (%)		
Ecoregions	*N*	Intensive[a]	Incidental[b]	Nothing
Blackland Prairie	32	19	63	19
Edwards Plateau	37	46	46	8
Piney Woods	155	18	63	19
Oak Woods Prairies	182	19	57	24
Rolling Plains	62	11	71	18
South Texas Brush Country	85	39	57	5
Trans Pecos	34	24	59	18

Who conducts feral hog control (% on multiple responses)?				
	Myself	WS[1]	Hunters	Private[2]
Blackland Prairie	68	0	32	0
Edwards Plateau	44	23	34	0
Piney Woods	67	1	29	2
Oak Woods Prairies	69	1	28	3
Rolling Plains	54	7	38	0
South Texas Brush Country	54	2	43	2
Trans Pecos	67	9	23	0

[a] Specific control measures carried out on a regular basis.

[b] Only when the respondent had time and the situation allowed it.

1 = Wildlife Services, 2 = Private control operators.

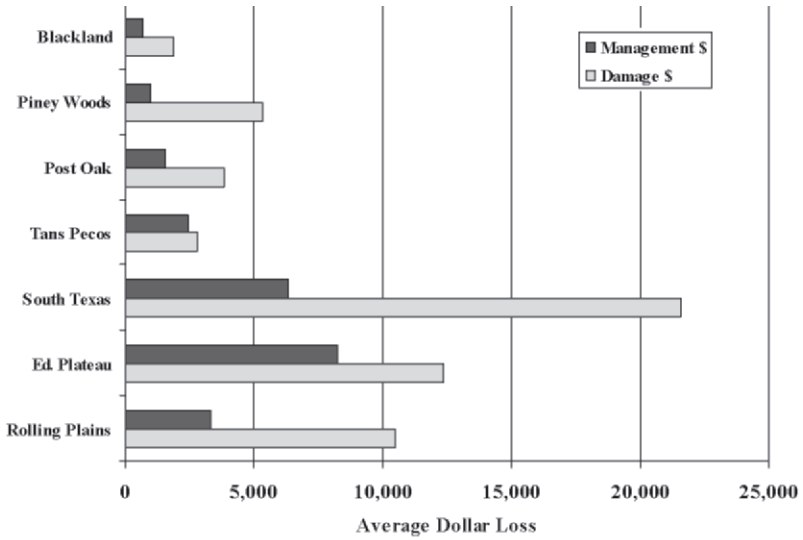

Figure 3. Average dollar losses due to feral hog damage and management in 7 ecoregions in Texas, as determined by survey conducted in 2003.

trol. Wildlife Management Services (WMS) was responsible for hog control only in the Edwards Plateau ecoregion (Table 2).

The 2 primary methods of feral hog control across all ecoregions were trapping (23–41%) and shooting (27–44%). However, the higher use of aerial hunting in the Edwards Plateau (16%) and South Texas Brush Country (14%) compared to ≤8% in other ecoregions and trailing and catch dogs in the Piney Woods (12%) compared to ≤8% in other ecoregions produced a response pattern that was dependent on region ($\chi^2 = 234.7$, $P = 0.0001$).

Region was not a factor that contributed to the respondents' (those with and without feral hogs) desire to participate in the 3 feral hog management opportunities listed earlier ($\chi^2 = 10.5$, $P = 0.772$).

Region accounted for differences in economic losses due to feral hog damage to respondents' property ($F_b = 2.3$, $P = 0.02$) and management costs ($F_b = 5.1$, $P = 0.001$). The highest average economic losses due to feral hog damage and management costs were in the South Texas Brush Country, Edwards Plateau, and Rolling Plains ecoregions (Figure 3).

Discussion

There is a great need for studies that address the attitudes, activities, and knowledge of landowners and managers regarding feral hogs. Such information is important to address the management concerns and educational needs of those who confront the problems of feral hog management on a daily basis. In this regard we discuss study results in terms of respondents' attitudes toward feral hogs, knowledge about feral hogs, and level of control and management including respondents' desire to participate in feral hog control and management opportunities.

Attitudes toward feral hogs

Respondents viewed feral hogs more as a negative aspect of the landscape rather than a positive opportunity to promote recreational hunting or realize some economic gain. Frederick (1998) reported $1,731,920 worth of damage caused by feral hogs in 40 California counties. Nearly 40 percent of the feral pigs in California are killed by hunters each year (Waithman et al. 1999). The income potential from feral hogs was millions of dollars based on the recreational value of hogs to hunters, lease hunting opportunities for landowners, taxidermy, and trapping (Degner et al. 1982).

There is some debate in Texas as to whether feral hogs are of any ecological importance, an economic liability, or an under-utilized asset (Tolleson et al. 1995). For example, many landowners support the spread of feral hogs because it offers a hunting opportunity that is more affordable than hunting other big game species. A 1992 survey indicated feral hog hunters paid in a range of $25–1,000 for a hog hunt with the average price paid being $169 (Rollins 1993). However, not enough people are hunting feral hogs to reduce their already enormous population ($n = 1{,}500{,}000$) in Texas. In Fort Riley, Kansas, public hunting proved to be relatively unsuccessful in controlling a feral hog population (Richardson et al. 1997).

Respondents' knowledge about feral hogs

The average quiz score of 11.5 indicated that respondents could correctly respond to <50% of the 26 questions. On several questions nearly 50% of the respondents were "not sure" which response was appropriate. Five statements (b, h, and o; Table 1) revealed a particular lack of understanding about feral hog biology in terms of the impact the animals

have on other wildlife, what feral hogs eat, and how many offspring they can have per litter. Respondents were either not sure or responded incorrectly to 2 regulatory statements (y and z; Table 1) related to the requirement of a hunting license to shoot feral hogs (44%), and restrictions on moving feral hogs in Texas (71%).

The impact of feral hog depredation on quail (*Colinus virginianus*) is still unclear due to the abundance of hogs in areas that simultaneously support the largest quail populations (Rollins and Carroll 2001). Others concluded that bobwhite quail decline was due to degradation and reduction of habitat, caused partly by changing land-use practices and urbanization across the bobwhite's range (Church et al. 1993). However, 68% of respondents believed that feral hogs were a serious threat to ground-nesting birds.

The diet of feral hogs consists primarily of plant material, whereas animal material represented a small portion of the hog's diet (Baber and Coblentz 1987, Taylor and Hellgren 1997). Yet 60% of respondents believed that feral hogs will eat anything they can catch alive or find dead. Litter sizes ranged from 4.8–7.5 young/litter (Taylor et al. 1998). Nearly half (44%) of respondents reported that 12 piglets per litter was the norm.

There are regulations concerning the movement of feral hogs throughout the state. The Texas Animal Health Commission (TAHC) has regulatory authority over feral swine in Texas. The TAHC regulation concerning feral swine trapped on a premise is that they are to be tested negative for brucellosis and pseudorabies within 30 days before they are moved to a game preserve or site where they will be maintained for hunting. This 1992 TAHC regulation was intended to prevent the spread of brucellosis and pseudorabies from feral swine to domestic stock. Nearly two-thirds of the respondents agreed or were not sure that feral hogs could be moved anywhere in the state without restrictions.

Over half (51%) of the respondents disagreed with the statement that feral hogs can be shot only by someone with a valid Texas hunting license. The TPWD code, chapter 42, (42.002c) states that a resident or the landowner's agent or lessee may take feral hogs causing depredation on the resident landowner's land without having acquired a hunting license. This law pertains also to nonresident landowners in TPWD code, chapter 42 (42.005f). It is uncertain whether those who correctly disagreed with the statement actually knew the TPWD codes pertaining to hunting license requirements or whether they considered the feral hog to be a nongame pest and therefore unregulated.

Level of control and management

Our results indicated that the level of control and management of feral hogs on respondents' property was incidental (when opportunity presented itself), did not involve professional animal damage control specialists, and was not a bottom-line operational cost. Incidental management of feral hogs also was common by California landowners (Barrett and Pine 1980). The feral hog problem is so enormous and pervasive throughout most of Texas that management attempts by 1 or a few landowners can be costly in time and money but fairly ineffectual in making any significant impact on the overall problem. The TPWD provides guidelines on how to form Wildlife Management Associations (WMAs) or Co-ops at the county level. The focus of WMAs is wildlife management on private lands by landowners with the assistance of TPWD field biologists. While typically focused on white-tailed deer (*Odocoileus virginianus*) management, the organizational paradigm that produces WMAs could be used to coordinate feral hog control and management at the county or regional levels. Half of the respondents were interested in doing something to become better prepared to control and manage feral hogs on their properties.

Management implications

Based on the respondents' knowledge of feral hogs, information and education should be expanded. This could include more informational brochures, seminars, and workshops. Knowledge and understanding of the basic biology of feral hogs will help manage the species. It also is important that the public understands the laws and regulations regarding feral hogs. Unfortunately, in Texas the feral hog is regulated by multiple agencies. Most sportsmen consider the feral hog wildlife, and, indeed, it is the second-most-huntable large-mammal species in Texas behind the white-tailed deer (Rollins 1993). The TPWD establishes hunting regulations; however, it considers the feral hog as an exotic game animal. The TAHC establishes movement regulations and Texas Department of Agriculture (TDA) regulates domestic hog producers including free-ranging marked hogs. The United States Department of Agriculture has regulations

governing the slaughter of feral hogs. The lack of single regulatory authority adds to the confusion among landowners about sources of information about feral hog management.

The feral hog is an underutilized resource in Texas. The amount of damage caused by feral hogs could be reduced if landowners would use the hog as an economic resource. Landowners could charge leasing rights, trophy fees, day fees, or barter for ranch improvements. In essence, they could turn an economic liability into an asset or at the very least, lower the liability. Landowners must be willing to change their outlook and incorporate hog management into their overall ranch-management plan. The average economic cost to control hogs was $2,631 (U.S.), and $169 (U.S.) was the average income per hog (Rollins 1993). If the average landowner sold 16 hogs, it would offset the average economic cost of feral hog control.

The ultimate application of our results is the impact they had on the public policy and decision-making processes. By providing briefings to state policy-makers, the outreach effort associated with the project has resulted in early efforts to provide financial resources for dealing with feral hog issues. For example, an extension specialist's briefing to the state Agriculture Commissioner and Agriculture Committee of the Texas House of Representatives highlighted these survey results. As a follow-up, in a subsequent issue of the State Comptroller's monthly financial report, a summary of these results was included as a feature. By presenting landowner perspectives on the issue along with some reliable estimates of economic damage, the policy-makers involved have been able to move from a question of "is this a problem?" to "how big a problem is this?" and then finally to "what can we do to manage this problem?" As a result, with an effort now supported by the TDA, the state is in the early stages of designing a pilot feral hog abatement program that is likely to receive legislative funding. In our view this is a classic case of complementary roles among research, extension, and policy-making.

Acknowledgments. The authors wish to thank A. Manley and T. Schields for data entry and D. Kubenka for constructing Figure 1. The project was funded by the National Park Service. The Texas A&M University Institutional Review Board on human subjects approved this study (Project # 2002-493).

Literature cited

BABER, D. W., AND B. E. COBLENTZ. 1987. Diet, nutrition, and conception in feral pigs on Santa Catalina island. Journal of Wildlife Management 51:306–317.

BARRETT, R. H., AND D. S. PINE. 1980. History and status of wild pigs, *Sus scrofa*, in San Benito County, California. California Fish and Game 67:105–117.

CHURCH, K. E., J. R. SAUER, AND S. DROEGE. 1993. Population trends of quails in North America. Pages 44–54 *in* K. E. Church and T. V. Dailey, editors. Quail III: Proceedings of the third national quail symposium. Kansas Department of Wildlife and Parks, Pratt, USA.

DEGNER, R. L., L. W. RODAN, W. K. MATHIS, AND E. P. J. GIBBS. 1982. The recreational and commercial importance of feral swine in Florida. Florida Agricultural Market Research Center Industry Report 82–1. University of Florida, Gainesville, USA.

FREDERICK, J. M. 1998. Overview of feral pig damage in California. Proceedings Vertebrate Pest Conference 18:82–86.

GIPSON, P. S., B. HLAVACHICK, AND T. BERGER. 1998. Range expansion of feral hogs across the central United States. Wildlife Society Bulletin 26:279–286.

HANSELKA, C. W., AND J. F. CADENHEAD, editors. 1993. Feral swine: a compendium for resource managers. Proceedings of a Symposium, March 1993. Texas Agricultural Extension Service, Kerrville, USA.

RICHARDSON, C. D., P. S. GIPSON, D. P. JONES, AND J. C. LUCHSINGER. 1997. Extirpation of a recently established feral pig population in Kansas. Proceedings of the Eastern Wildlife Damage Management Conference 7:100–103.

ROLLINS, D. 1993. Statewide attitude survey on feral hogs in Texas. Pages 1 - 8 *in* C.W. Hanselka and J.F. Cadenhead, editors. Feral Swine: A Compendium for resource managers. Texas Agricultural Extension Service, Kerrville, USA.

ROLLINS, D., AND J. CARROLL. 2001. Impacts of predation on northern bobwhite and scaled quail. Wildlife Society Bulletin 29:39–51.

SCHUETT, M. A., AND S. SELIN. 2002. Profiling collaborative natural resource initiatives and active participants. Northern Journal of Applied Forestry 19:155–160.

TAYLOR, R. 1993. History and distribution of feral hogs in Texas. Pages 17 to 25 *in* C.W. Hanselka and J.F. Cadenhead, editors. Feral swine: a compendium for resource managers. Texas Agricultural Extension Service, Kerrville, USA.

TAYLOR, R., AND E. HELLGREN. 1997. Diet of feral hogs in the western South Texas Brush Country Plains. Southwestern Naturalist 42:33–39.

TAYLOR, R., E. HELLGREN, T. GABOR, AND L. ILSE. 1998. Reproduction of feral pigs in southern Texas. Journal of Mammalogy 79:1325–1331.

TOLLESON, D. R., W. E. PINCHAK, D. ROLLINS, AND L. J. HUNT. 1995. Feral hogs in the rolling plains of Texas: perspectives, problems, and potential. Great Plains Wildlife Damage Control Conference12:124–128.

WAITHMAN, J. D., R. SWEITZER, D. VAN VUREN, J. D. DREW, A. J. BRINKHAUS, I. A. GARDNER, AND W. M. BOYCE. 1999. Range expansion, population sizes, and management of feral pigs in California. Journal of Wildlife Management 63:298–308.

WILKINS, N., A. HAYS, AND D. KUBENKA. 2003. Texas land trends. Land information systems. Available at: http://landinfo.tamu.edu/frag. [Date accessed July 2004.]

WOLF, T., AND M. R. CONOVER. 2003. Feral pigs and the environment: an annotated bibliography. Berryman Institute Publication 21. Utah State University, Logan, USA and Mississippi State University, Starkville, USA.

Associate editor: *Krausman*